

Water Reuse

Where we have been & where we are going

Nationally, Arizona and Flagstaff

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Utilities Director

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Flagstaff Water Works Part III

Friends of the Rio de Flag / F³

February 6, 2014



Goals of Tonight

- **History & Importance** of reclaimed water
(Arizona & Flagstaff)
- How **Flagstaff treats & uses** reclaimed water
- **Current Issues** in the utility industry
- **Future** of reclaimed water
(Arizona & Flagstaff)



"Terms of Endearment"

Reclaimed water = Recycled water =
Water reuse = Effluent

Acre-foot ~ amount of water that 4 Flagstaff households use in 1 year (or 325,851 gallons)

Class A+ = highest level of treatment in Arizona: primary/secondary treatment, filtered & disinfected. 5-month geo-mean Nitrogen < 10 mg/L, turbidity < 2 NTU, fecal coliform counts, non-detect (4 of 7 days)



"Terms of Endearment"

DIRECT Reuse: "purple pipe" distribution,
irrigation, power generation, environmental habitat

INDIRECT Reuse: recharge into groundwater
or discharge into surface water, then reuse as a
co-mingled supply

surface water – Colorado or Mississippi Rivers

groundwater - recharge & recovery (Recovered Reclaimed)





2008 Beijing Olympics Birds Nest



60 MGD or 30%
of Singapore's water use



Courtesy of Office of the Governor of the State of California

Tampa Bay Area
167,000 AF/yr or 149 MGD

Orange County Groundwater Replenishment System



78,400 AF/year or 70 MGD

San Antonio Riverwalk

35,000 AF/year or 31 MGD



Southwest Florida
Water Management District

BALANCING WATER NEEDS... PROTECTING WATER RESOURCES

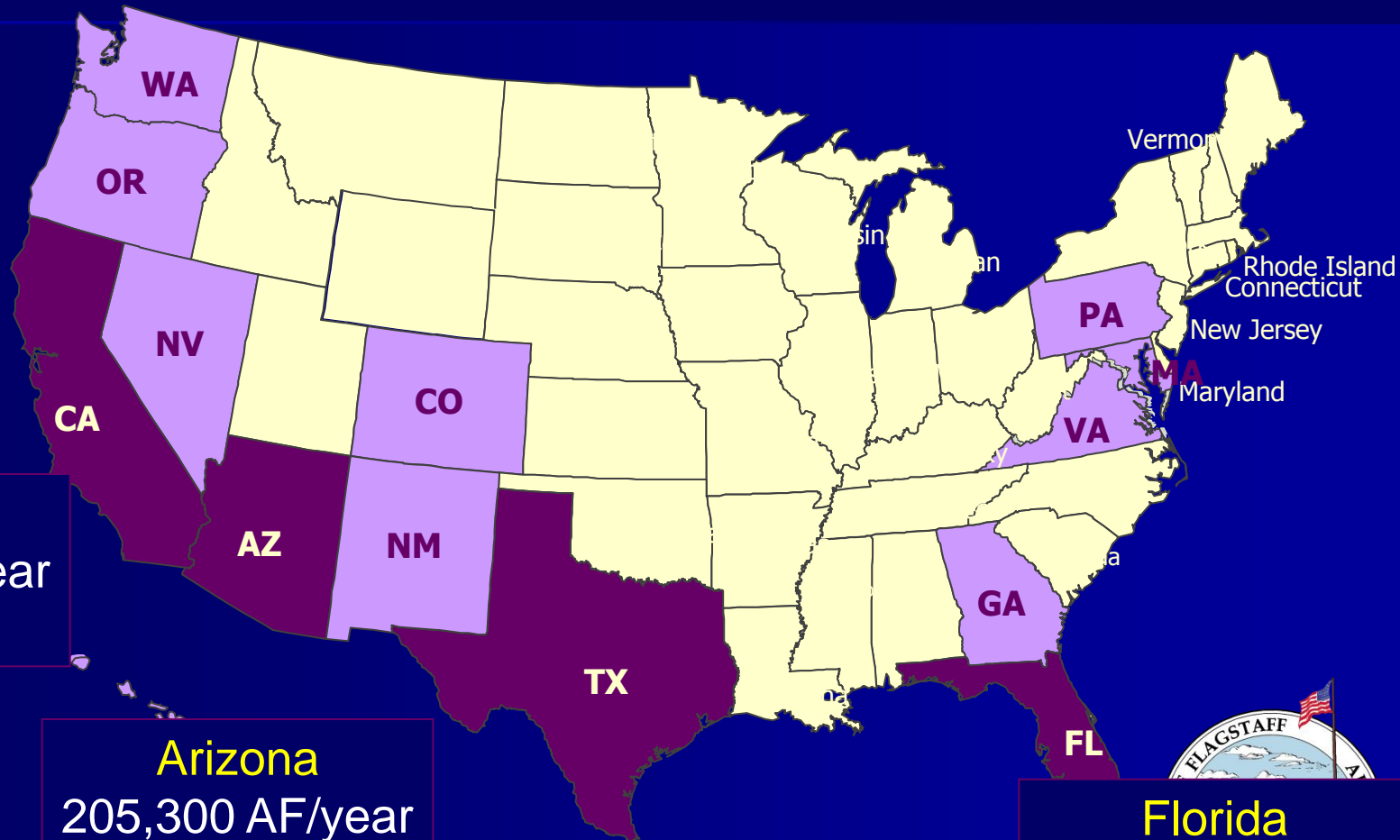
- About the District
- Agriculture
- Boards, Meetings & Events Calendar
- Business & Finance
- Data & Maps
- Documents & Publications

WATER
RESTRICTIONS



Nationally, Arizona is a Leader

90% of reuse occurs in just four states



California

616,100 AF/year
550 MGD

Arizona

205,300 AF/year
183 MGD

Florida

742,700 AF/year
663 MGD



Arizona's Legislative Authority over Reclaimed Water



1986 & 1994 – Water Management tool Legislature established the Underground Water Storage and Recovery Program (**Recharge & Recovery**)

1989 – Arizona State Supreme Court ruled "**effluent**" a separate legal type of water and established who owns the water



1999 – Legislature gave ADEQ clear authority to regulate reclaimed water quality, permitting, etc



Reclaimed Water Quality Regulations



- USEPA National Pollutant Discharge Elimination System program (Arizona has primacy)

E Coli & Metals (Selenium, Cyanide, Copper Mercury)

- ADEQ Aquifer Protection Permit – discharge

E Coli, Nitrogen, metals, organic compounds, turbidity

Reclaimed Quality Class B, Class A & Class A+

filtration, disinfection, nitrogen & turbidity



Arizona Water Reuse

Current Status

Direct Reuse:



City of Tucson

Delivering reclaimed water since 1984.

Today **18** golf courses, **50** parks, **65** schools and **700** single family homes (**30 MGD in summer**)

City of Flagstaff

Delivering reclaimed water since early 1970s.

Today **3** golf courses, **15** parks, **10** schools and **12** single family homes (**2.6 MGD in summer**)



Arizona Water Reuse

Current Status

Recharge & Recovery: many Arizona communities recharge their excess reclaimed water

**Salt River Project
New River – Agua Fria Recharge Project**
“constructed facility”

Glendale's
Westgate/Cardinals Stadium



Partnership

SRP, Avondale, Chandler,
Glendale & Peoria



Arizona Water Reuse

Current Status

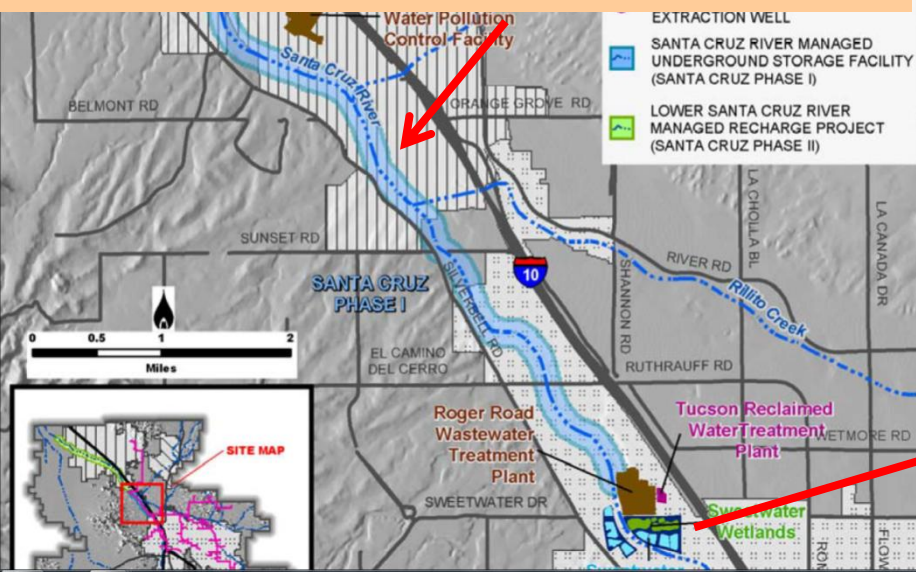
Groundwater Recharge § 45-802 (2 types under State Law)

29 Underground Storage Facilities permitted to recharge reclaimed water (>263,000 AF/year or 235 MGD)

Managed – natural channel

Constructed – engineered & designed

City of Tucson Sweetwater Managed Recharge Site - reclaimed water

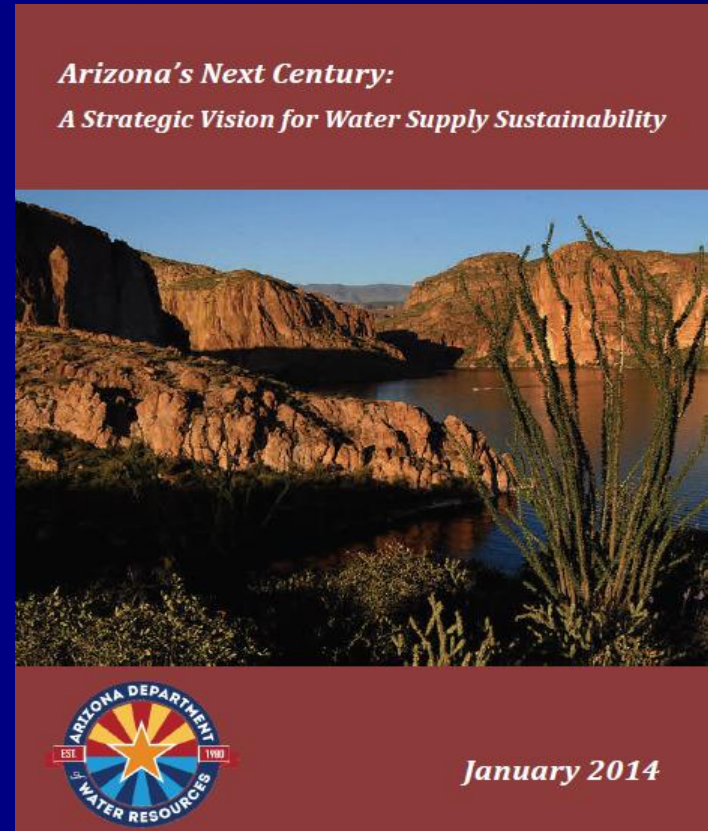
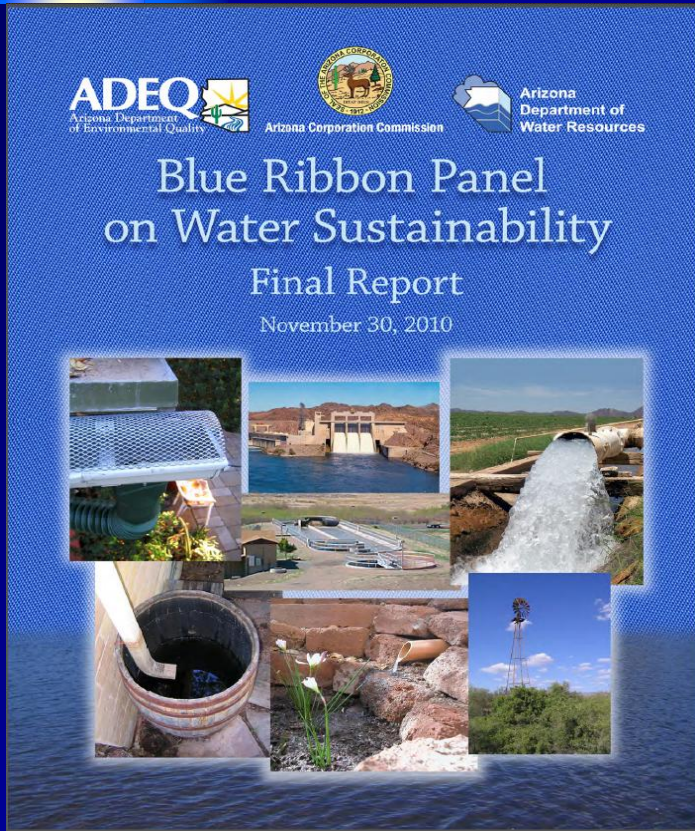


City of Tucson Sweetwater Constructed Recharge Site – reclaimed water



Governor's Blue Ribbon Panel 2010

Governor's Arizona's Next Century: A Strategic Vision for Water Supply Sustainability 2014



Continued conservation & expand reuse of reclaimed water



Flagstaff

Current Status



Wildcat Hill Wastewater Treatment Plant (6 MGD)

constructed in 1973 Purpose to provide **Class B** quality reclaimed water for golf course irrigation & amenity lakes

upgrade completed in 2010 Purpose of upgrade to **Class A+** quality and connect into reclaimed distribution system

(plant only treats consistently to Class A)



May 2013 City was issued
Consent Order



Flagstaff

Current Status



Pine Canyon golf course

Rio de Flag Water Reclamation Facility (4 MGD)

Constructed in 1993 Purpose to provided **Class A+** quality reclaimed water within reclaimed distribution system

Today City has 38 Customers @ 72 direct delivered reuse sites

irrigation, construction, industrial, commercial and environmental benefits



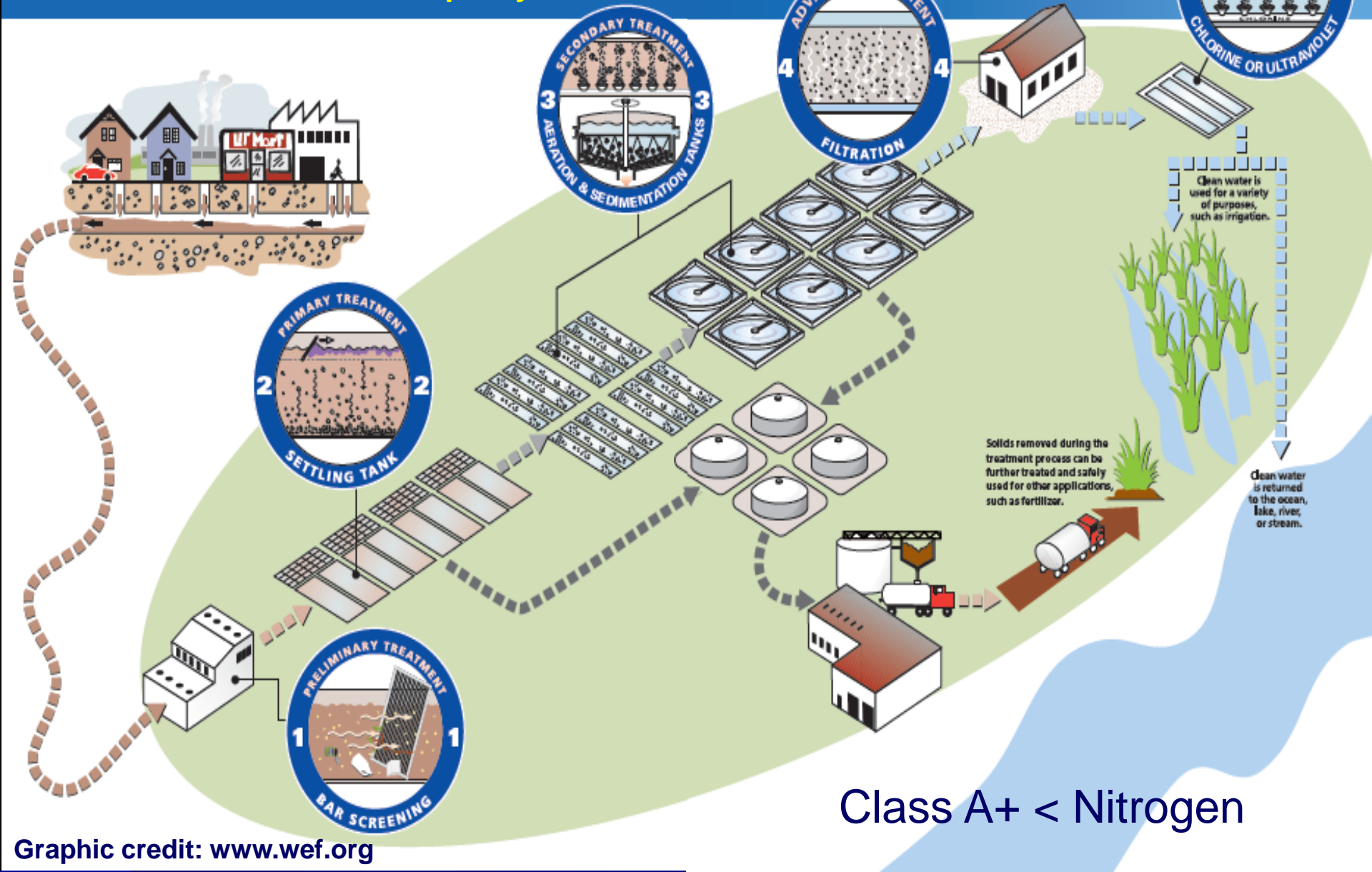
Reclaimed
Fire Hydrant



Rio de Flag
Wetlands

5 Steps to Clean Water

Class A quality



Class A+ < Nitrogen

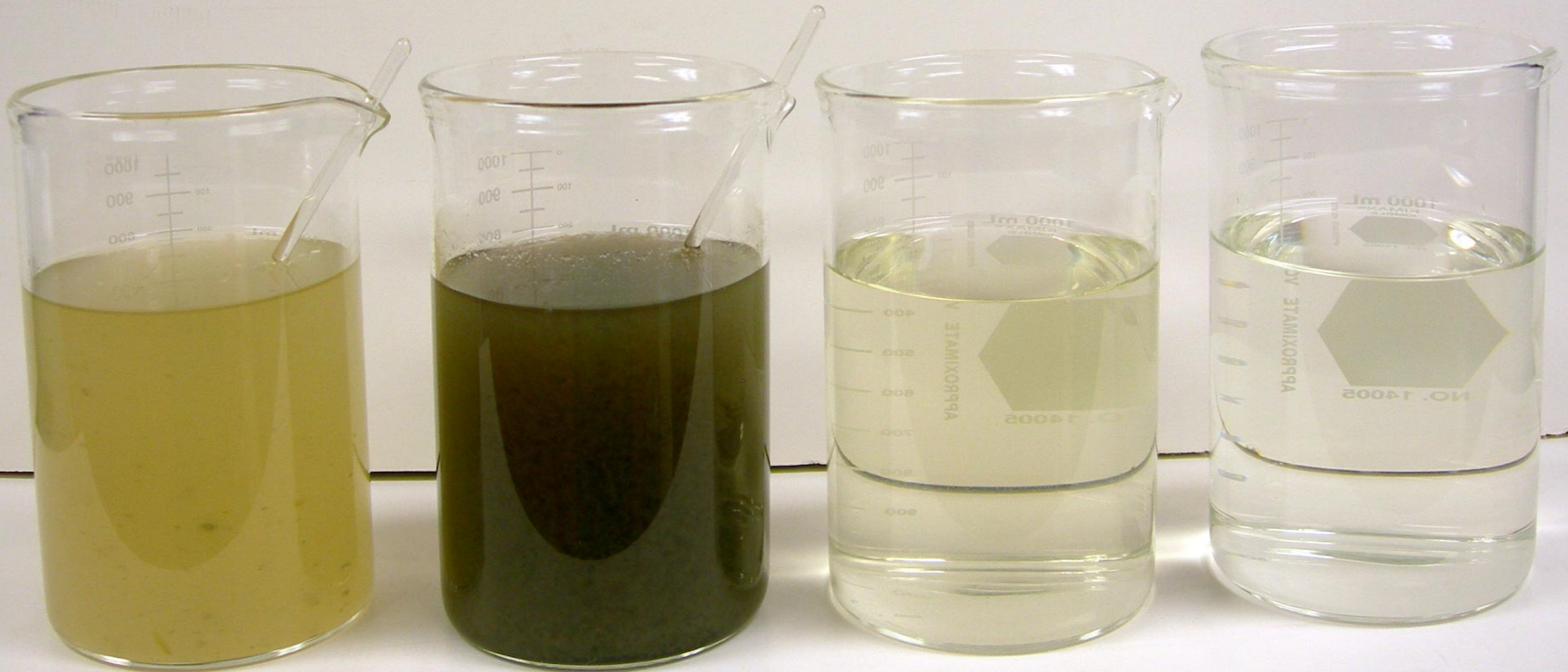
From Wastewater to Class A+ Reclaimed Water

RAW INFLUENT

MIXED LIQUOR

SECONDARY EFF.

FINAL EFFLUENT



Reclaimed Water

Important Water Management tool
for our Community

Water Conservation

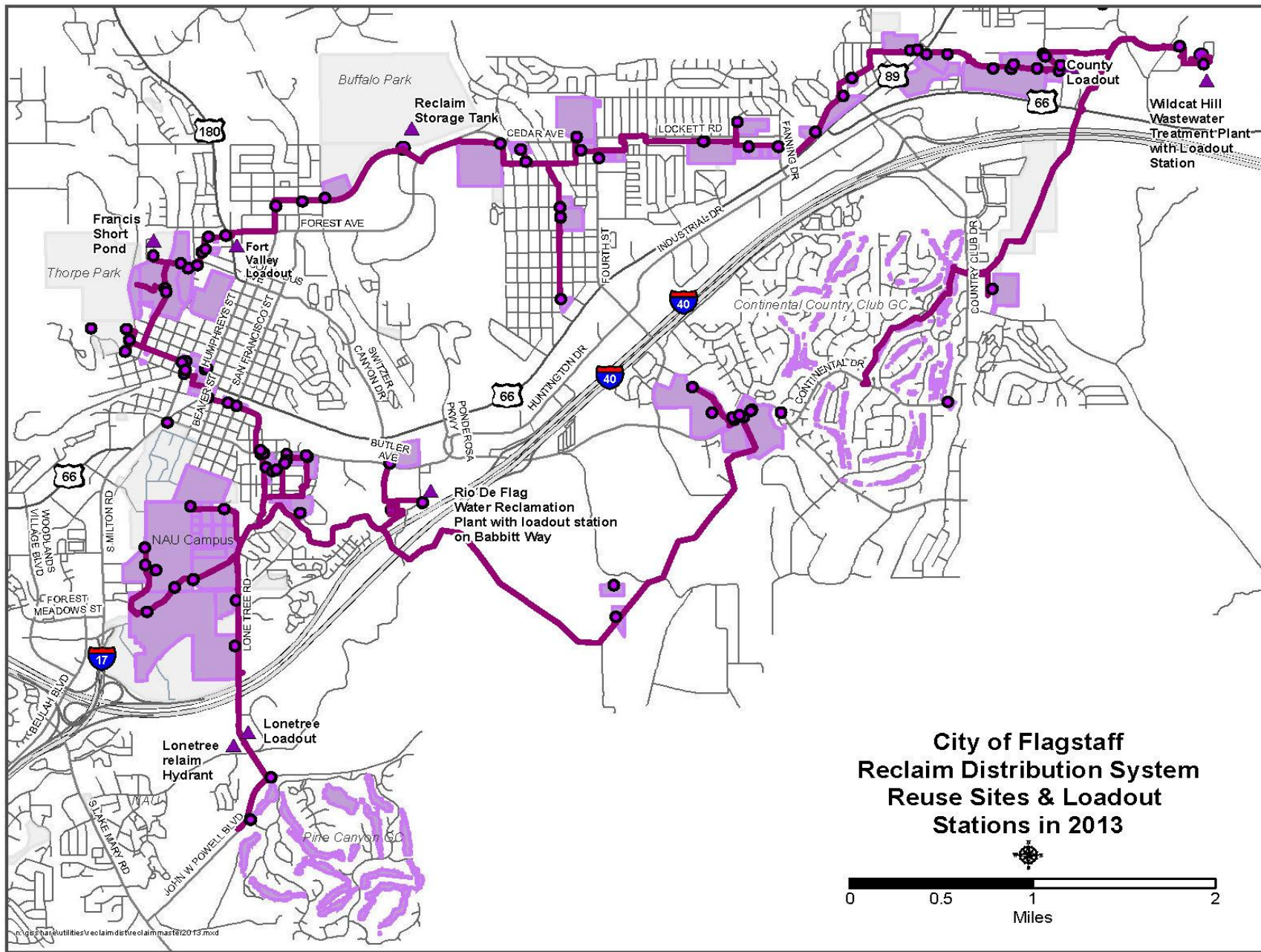
1. Use of reclaimed water where drinking water is not needed
(~2,100 AF/year or ~684 million gallons)
(Discharge ~3,800 AF/year into Rio de Flag)
2. Reclaimed water now makes up **20% of all water used in Flagstaff**
3. Helps to delay acquisition of new water supplies



SCA Group

SCA is a global hygiene and
forest products company





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Water Supply Augmentation & Resiliency to Climate Change

UTILITIES INTEGRATED MASTER PLAN

Water Resources Chapter

Water History, Demand, Existing Supplies
and Future Water Needs and Recommended Options



April 8, 2011

City of Flagstaff - Utilities Division



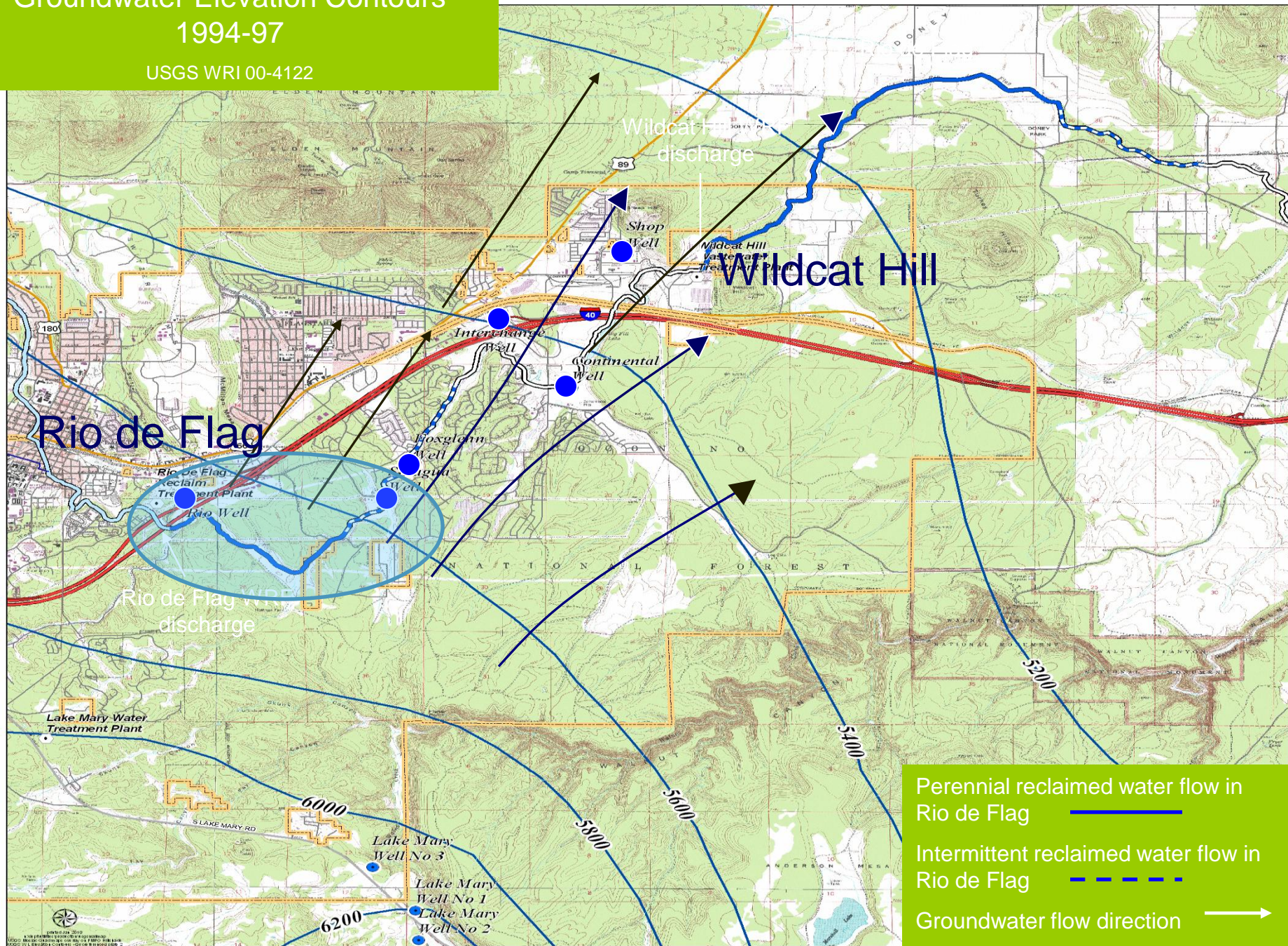
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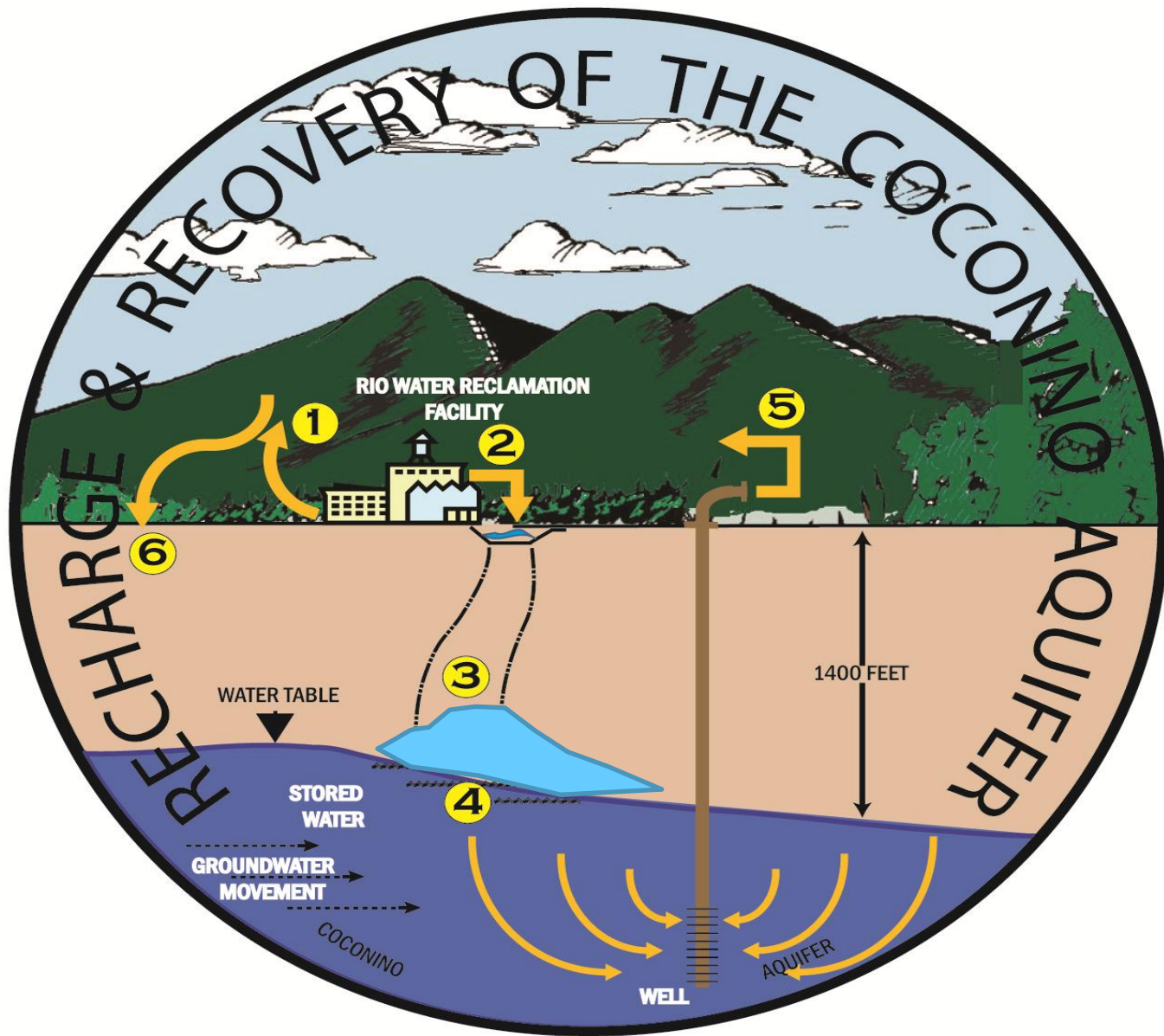
1. Water Resources Master Plan
2. Only water supply that grows with the Community
3. 2013 treat ~5,900 AF by 2080 >15,200 AF
4. Recharge underground unused supply by discharging into Rio de Flag today ~66% of total
 - i. augmentation of groundwater supplies
 - ii. potential future direct reuse



Groundwater Elevation Contours 1994-97

USGS WRI 00-4122

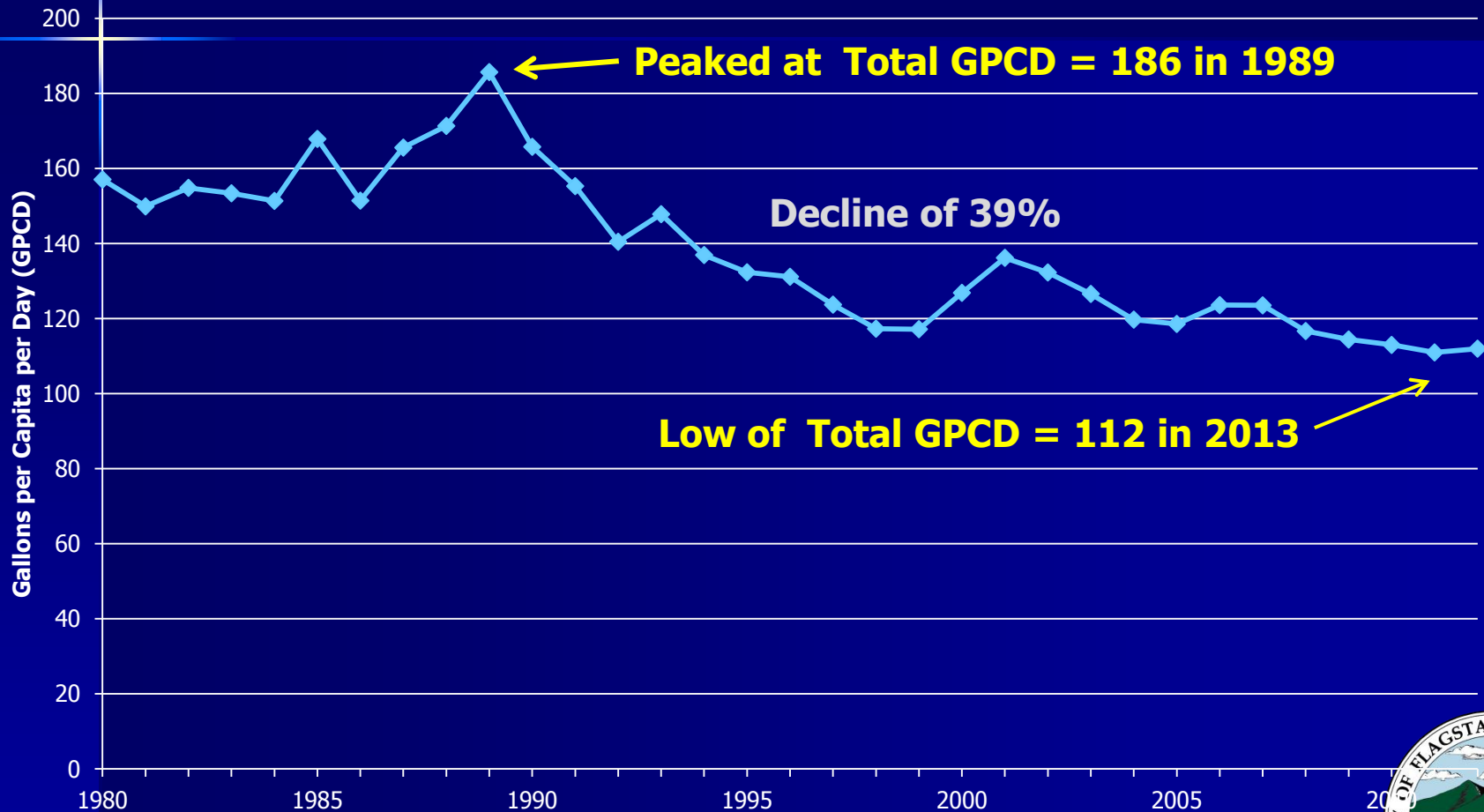




Conceptual Illustration

Historic drinking water use – GPCD

Gallons per Capita per Day



Peaked at Total GPCD = 186 in 1989

Decline of 39%

Low of Total GPCD = 112 in 2013

Residential: 56 GPCD – *Lowest in State*
Non-Residential: 42 GPCD



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Compounds of Emerging Concern

- "CEC"
- Chemicals (pharmaceuticals, hormones, endocrine disrupters)
- Microbial (pathogens, viruses, etc)
- Antibiotic Resistance Bacteria
- Analytical Testing Equipment
 - Parts per Million (mg/L) 10^{-6} 32 seconds in a year
 - parts per Billion ($\mu\text{g/L}$) 10^{-9} 3 seconds in 100 years
 - Parts per Trillion (ng/L) 10^{-12} 3 seconds in 100,000 years
 - Parts per Quadrillion (pg/L) 10^{-15} 2.5 minutes in 4.5 billion years



Trace Organic Compounds Come From Many Sources



Antibacterial hand soap
triclosan



Birth control pill
ethinyl estradiol



Coffee
caffeine



Polycarbonate plastic
bisphenol-a



Fire extinguisher
TDCPP, TCEP, TCPP



Insect repellent
DEET



Compounds shown represent only a small portion of all compounds to be analyzed

CEC's Pharmaceuticals, etc...

UNREGULATED

Nationally, USEPA is looking at this issue in **Drinking Water Systems**

Contaminant Candidate List #3

Focuses on human health (consumption...) & not by contact with reclaimed irrigation, etc

7,500 potential chemical & microbial contaminants
USEPA identified 600 warranted further evaluation

CCL #3 = **116** based upon occurrence & potential health effects



Unregulated CEC Sampling

Flagstaff is being Proactive

- **2002** Evaluated existing Rio WRF data with USEPA drinking water standards
- **2002-2006** city funded drinking & reclaimed water
USGS tested Rio WRF, Continental & Woody Mtn wells
NAU conducted tests of reclaimed water on Mosquitofish, Bullfrogs & African clawed frogs

NAU Summary Report to the City of Flagstaff on
Pharmaceuticals and Organic Contaminants in City
Wastewater and Well Water

Presented to the City of Flagstaff

By

Catherine Propper, Ph.D.
Professor
Department of Biological Sciences
Northern Arizona University

November 6, 2006



Unregulated CEC Sampling

Flagstaff is being proactive

- **2010** Sampled drinking & reclaimed water for 87 CECs
- **2011** Sampled Lake Mary water for 90 CECs
- **2012** Sampled Reclaimed Water to evaluate compliance with USEPA Safe Drinking Water Act
 - Reclaimed water meets Safe Drinking Water standards



State of Arizona

Compounds of Emerging Concern

- ADEQ – convened an **Advisory Panel on Emerging Contaminants** in 2012
 - Where they are found in Arizona waters
 - What are the known ecological & human impacts
 - Recommendations for Utilities – treatment techniques
 - Recommendations for the public



Arizona Department
of Environmental Quality

Press Release

1110 West Washington Street • Phoenix, Arizona 85007 • azdeq.gov

DATE: June 15, 2012

CONTACT: Mark Shaffer, Director of Communications, (602) 771-2215 (o);
(480) 433-9551 (cell)

**ADEQ Seeking Applicants for Panel to Examine Contaminants
That May Have Impacts on Drinking Water of Arizona**



Arizona Department
of Environmental Quality

City Manager's Advisory Panel

Compounds of Emerging Concern

12 Advisory Panel Members

Research Scientists from NAU, University of Arizona & Virginia Tech
Epidemiologist - TGEN North
Pathologist - Flagstaff Medical Center
Hydrologist - USGS
Water Resource Manager – Cottonwood
Coconino County Health Dept
Emergency Room Physician

*Focus on human health impacts, not
environmental impacts at this time*

Flagstaff City Manager's Compounds of Emerging Concern Advisory Panel – Interim Report

The City Manager's Advisory Panel on Compounds of Emerging Concern (CEC) met several times in the first half of 2013. The result was some helpful advice regarding the management of CECs in the City's drinking, wastewater and reclaimed water.

Background

As a precursor to those results, it should be noted that solving a scientific problem in a political environment is a very challenging merger of practices and perspectives. To start, the science associated with water, wastewater and reclaimed water utilities is extremely detailed and complex. No single study, investigation or finding can provide enough data to make an informed business decision. Politics and media coverage often look for the single discovery as evidence of a conclusion or the sole motivation for action. Science is based upon multiple replicated, controlled studies. And even after that string of investigations and results, the decisions implemented must be regularly tested, reviewed and analyzed. With that as a background, the panel of distinguished experts felt comfortable providing the City Manager the following advice.

As a framework, the Panel divided CECs into three categories: pharmaceuticals, endocrine disruptors, and antibiotic resistance genes (ARG). Upon further discussion, the Panel also categorized CECs into chemical and microbial – pharmaceuticals and endocrine disruptors being the former and antibiotic resistant genes and any associated bacteria (ARB) being the latter.

Further, the universe of research is enormous and the City Manager had to prioritize what was most critical to addressing the concerns raised by the utility operation. To that extent, he asked the Panel to focus on "human health effects" as opposed to animal, aquatic or environmental impacts. All are important and not necessarily mutually exclusive, but this work required a starting point.

INTERIM REPORT

July 16, 2013

Findings/Advice – Drinking water:

USEPA from advice from various national analytical studies created Contaminant Candidate Lists (CCL) may warrant future regulation in drinking water. *Antibiotic Resistance Genes are not on The CCL3 list, but 9 hormones & 1 antibiotic are on list.*
No documented study exists from around the world on human health impacts

Recommended the City consider evaluating which contaminants are on the list that are being utilized or prescribed in Flagstaff in preparation for future regulations

INTERIM REPORT

July 16, 2013

Findings/Advice – Reclaimed water:

1. There are **no data** at the present time to suggest that the **continued use of reclaimed water provides undue risk** to human health
2. Panel recommended the **City to monitor four chemicals** on the CCL #3 drinking water list in the City's reclaimed water
3. Create a Subgroup of Panel tasked with **outlining a cutting edge epidemiological & microbial study**
4. City to study to **compare effects of various advanced treatment technologies**

Flagstaff City Manager's
Compounds of Emerging Concern
Advisory Panel – Interim Report

City Manager's Advisory Panel

Compounds of Emerging Concern

Sub Group Proposal

FLAGSTAFF RESEARCH PROJECT seek funding:

Identify what, if any, ARB's are found leaving the treatment plants.

Identify what, if any, ARB's are found in the distribution system.

Identify if any of the ARB's are found in raw or drinking water.

Identify where any of the ARB's are most prevalent

(ex: soil, raw meat, medical clinics, etc).

Identify what are the most common ARB's encountered at FMC or in the Flagstaff medical community.

Identify what treatments kill or remove ARB's in water.

How has the use of chlorine & UV in the reclaimed distribution system affected detection of ARB's?

*Seeking grants from USEPA &
National Science Foundation*

Flagstaff City Manager's
Compounds of Emerging Concern
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Reclaimed Water

Planning for the Future

Reclaimed water grows with the community over time

- how to manage the supply into future?

Advanced Treatment of Reclaimed Water

- Utility industry ahead of regulations in developing advanced treatment to remove CECs
- Analytical testing equipment - how to define “clean” is clean?

Direct Potable Reuse?

- Guidelines are being established by the State's of California (prescribed treatment type), Texas (define water quality objectives) and now Arizona (hybrid approach)



Utility Industry has developed technologies to remove CECs

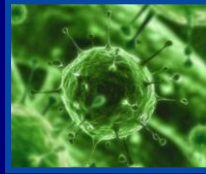
- **FILTRATION**: Microfiltration (**MF**) followed by reverse osmosis (**RO**) removes most trace organic compounds.
- **OXIDATION**: More persistent compounds can be destroyed to a large degree by advanced oxidation processes (**AOP**):
 - Ozone
 - Ultraviolet radiation (UV)
 - Hydrogen Peroxide
 - Peracetic acid

Membranes Can Effectively Remove Most Trace concentrations of CECs

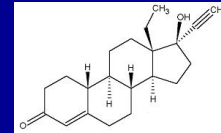
Bacteria



Viruses



Trace CECs



Costs to Implement Advanced Treatment for Flagstaff

HiPOX Water Reuse Solutions

VERY PRELIMINARY
Advanced Filtration & Oxidation

- using cost estimates from around USA -

*could be \$45M to \$70M
for both Wildcat & Rio treatment plants*



SUMMARY

Reclaimed water is a valuable water supply, not dispose

Flagstaff has invested huge sums of \$\$ to treat
reclaimed water highest quality permitted by law

20% of community's total water use is reclaimed water

Reclaimed water supply will grow with time

Flagstaff uses established Best Management Practices

- Direct or Indirect reuse of reclaimed water
- How to manage increases into the future



SUMMARY

State of Arizona & City of Flagstaff **Advisory Panels** are addressing issues of *unregulated CECs*

City of Flagstaff is proactive in CEC sampling and looking to participate in future research

Utility industry nationally has been **proactive in developing advanced treatment technologies**

Direct Potable Reuse in the future? **technology exists, State standards are being drafted, but is there public acceptance?**

